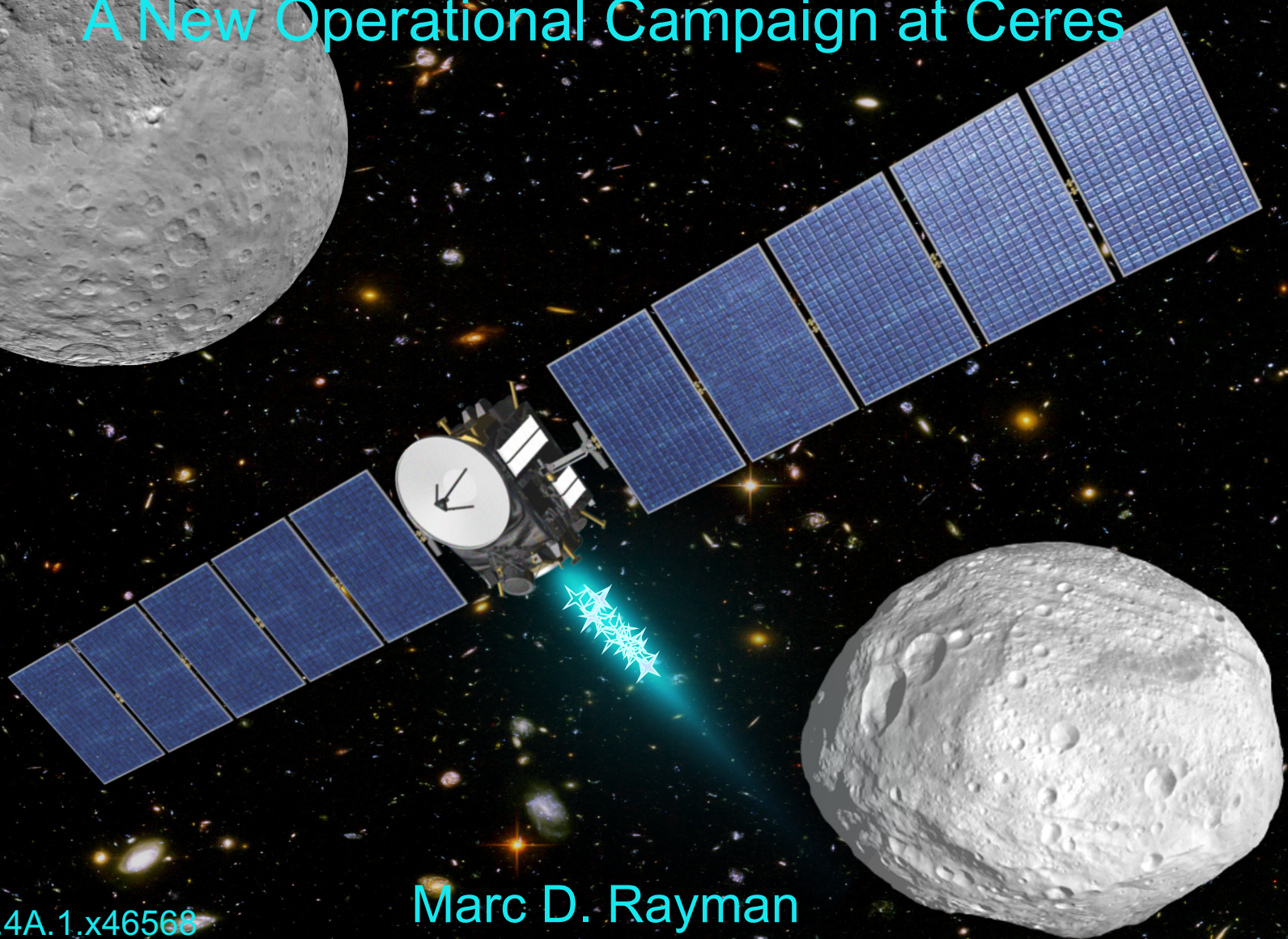


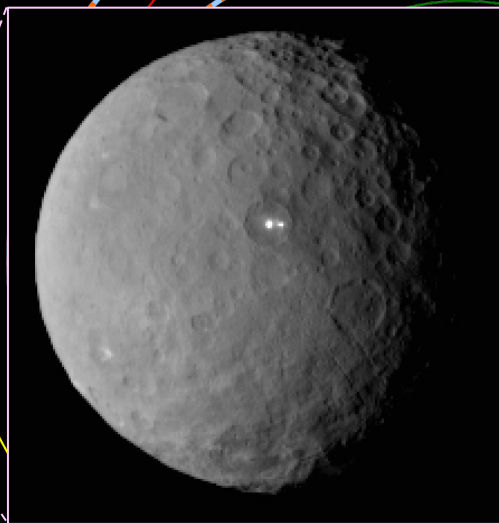
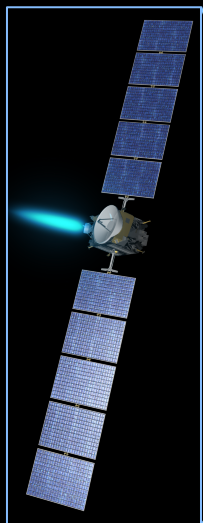
Dawn's Second and Final Extended Mission: A New Operational Campaign at Ceres



IAC-18.A3.4A.1.x46568

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Jet Propulsion Laboratory
California Institute of Technology



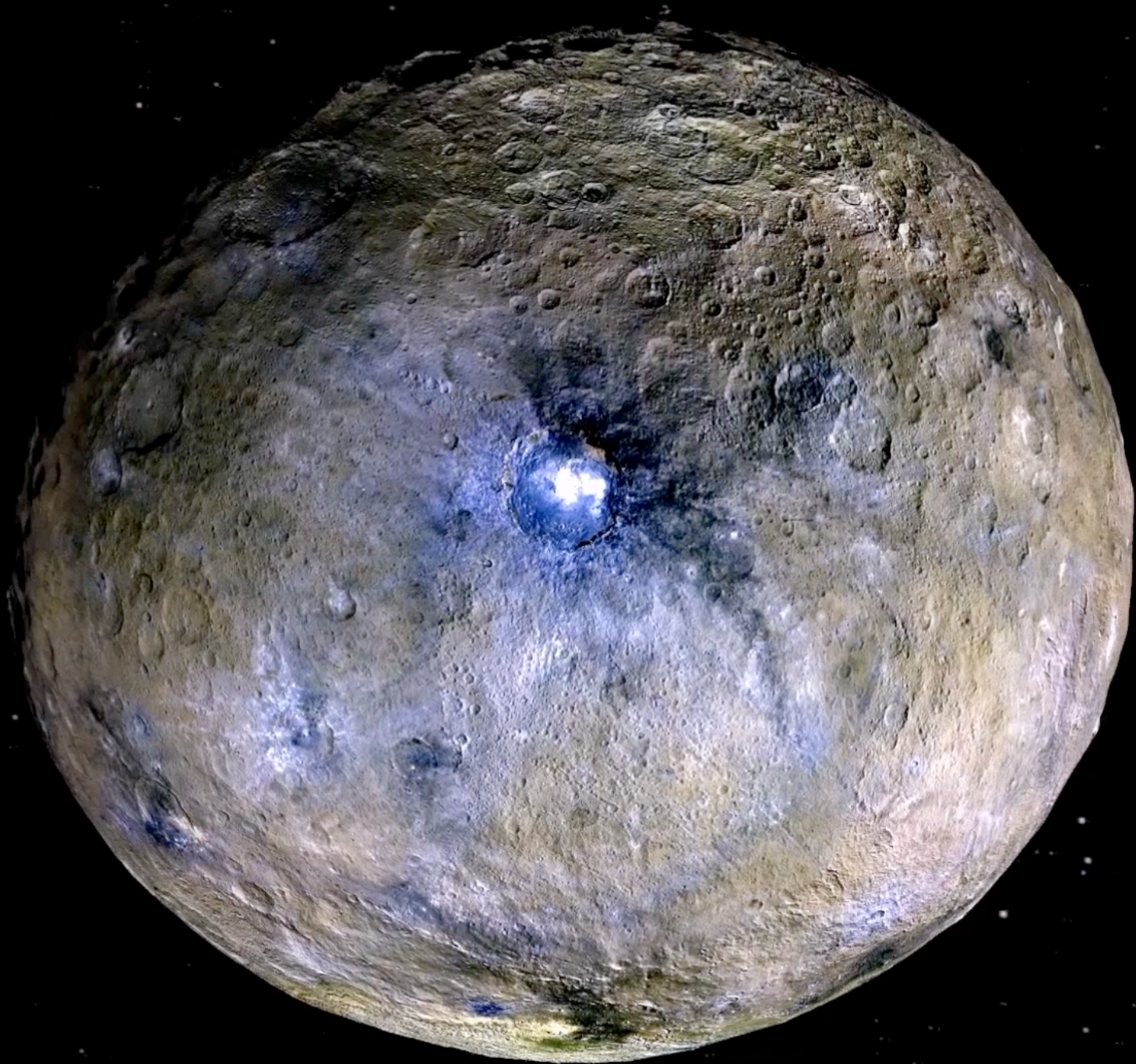
— Thrust
— Coast

Launch
Sep '07

Vesta
arrival

Mars gravity assist
Feb '09

Ceres arrival
Mar '15



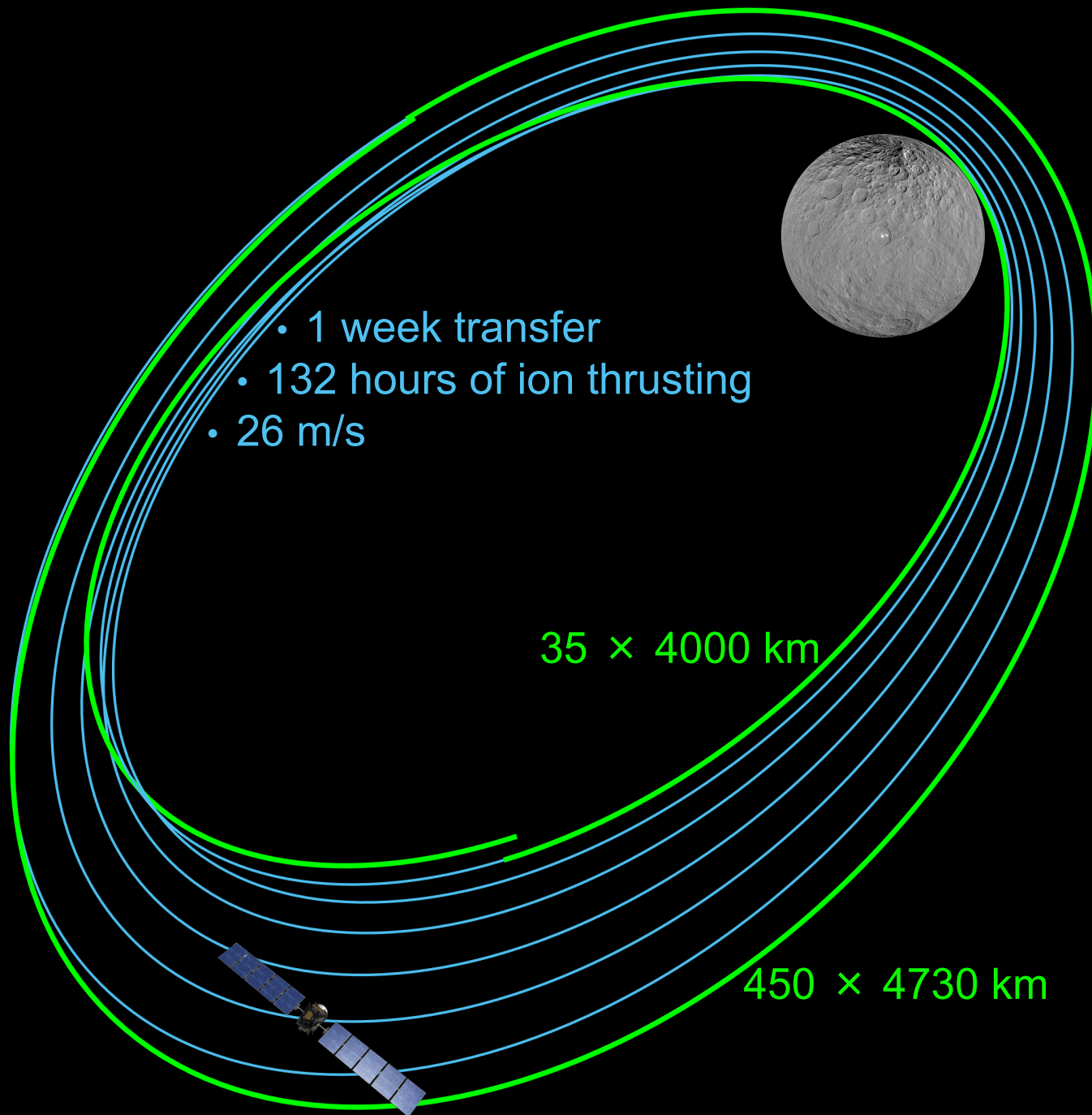


The diagram illustrates a satellite transfer orbit. A large, highly elliptical red orbit represents the transfer path. At its lower perigee, a satellite is shown. At its upper apogee, it intersects with a series of concentric blue elliptical orbits representing the target orbit around a central body (depicted as a grey sphere). The dimensions of the transfer orbit are given as 5400 x 38,000 km. The dimensions of the innermost target orbit are given as 450 x 4730 km. A list of mission parameters is provided in the center of the diagram.

5400 × 38,000 km

450 ×
4730

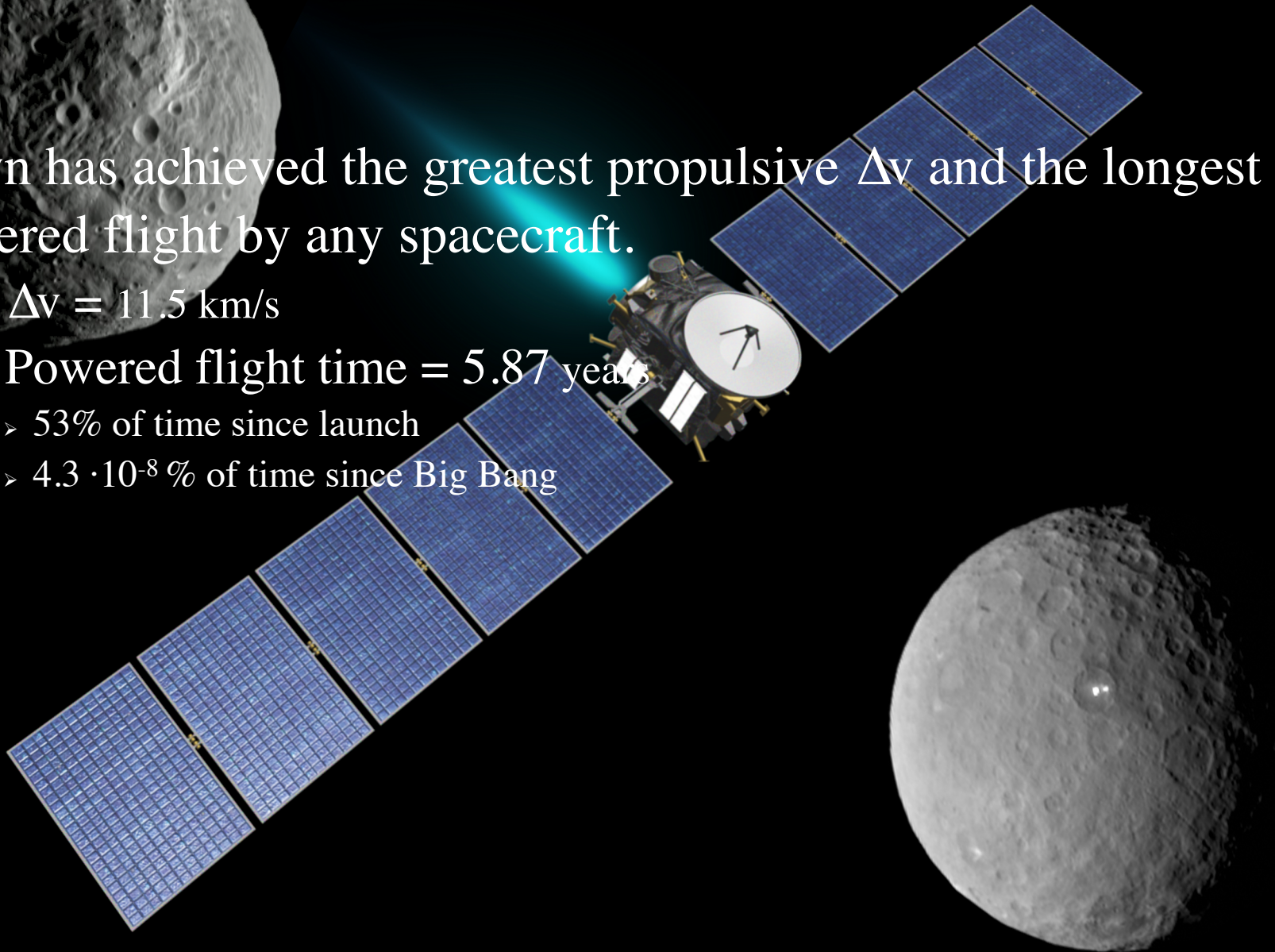
- 4 week transfer
- 631 hours of ion thrusting
- 121 m/s



Ion Thrusting Accomplishments

Dawn has achieved the greatest propulsive Δv and the longest powered flight by any spacecraft.

- $\Delta v = 11.5 \text{ km/s}$
- Powered flight time = 5.87 years
 - 53% of time since launch
 - $4.3 \cdot 10^{-8} \%$ of time since Big Bang



Dawn's Current (and Final) Orbit

27.3 hour period

3:1 synchronous with Ceres rotation,
with periapsis at longitude of Occator Crater

4,000 km
apoapsis

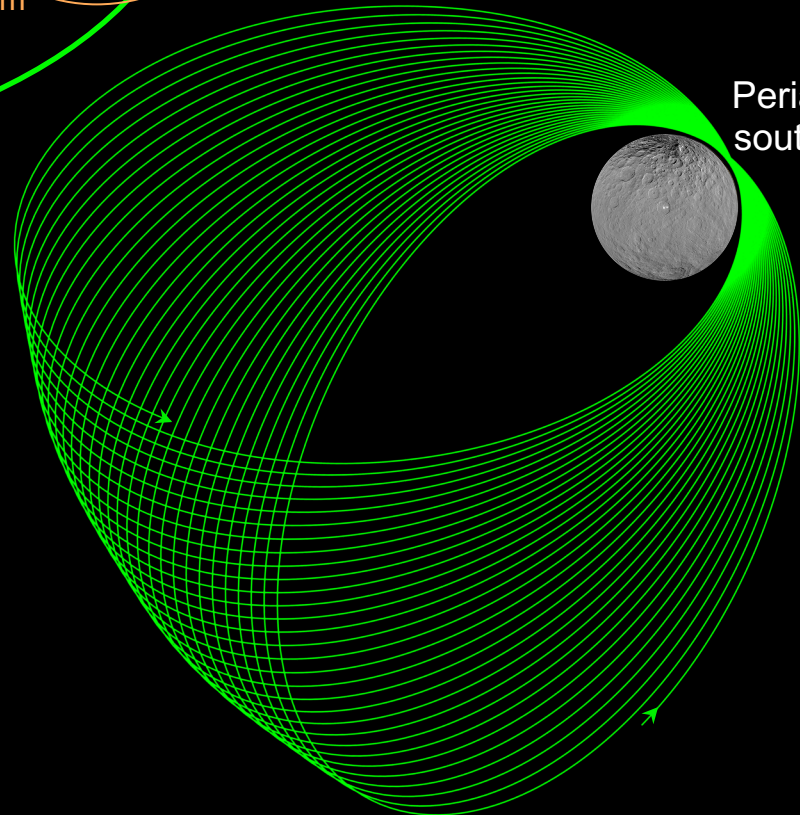
35 km
periapsis

Previous lowest
altitude was 385 km

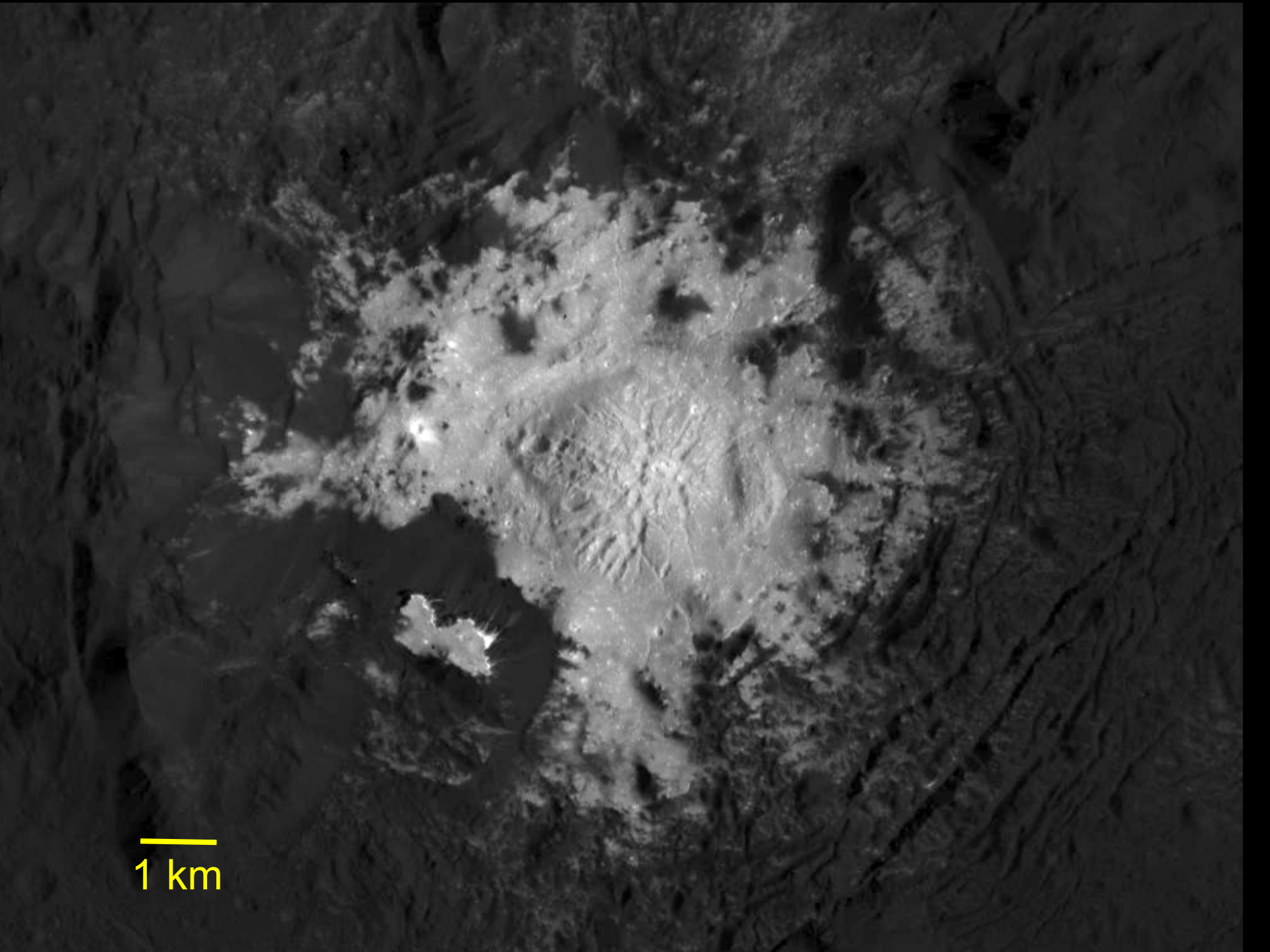


Near periapsis, Dawn acquires

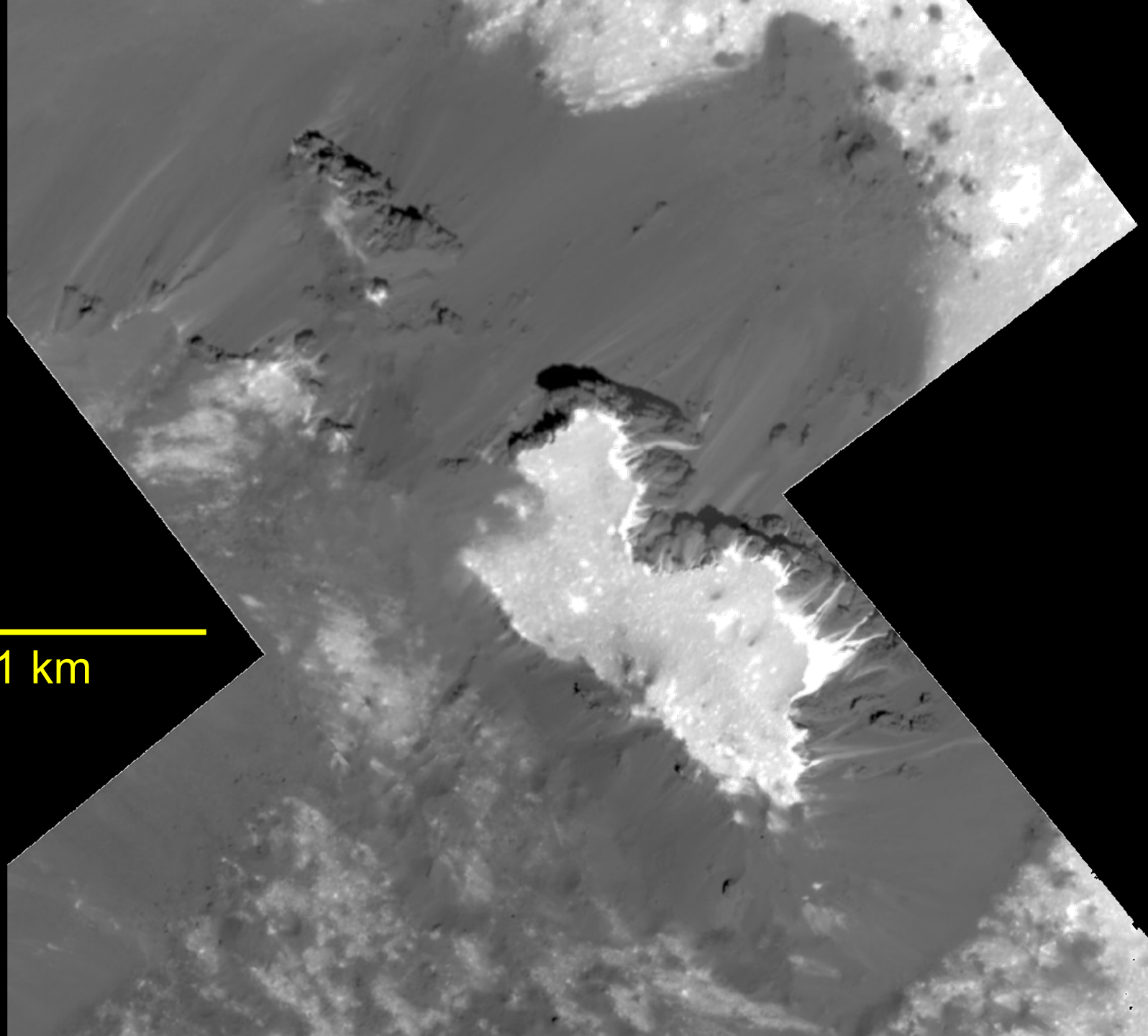
- Images
- IR spectra
- Neutron spectra
- Gamma-ray spectra
- Gravity data



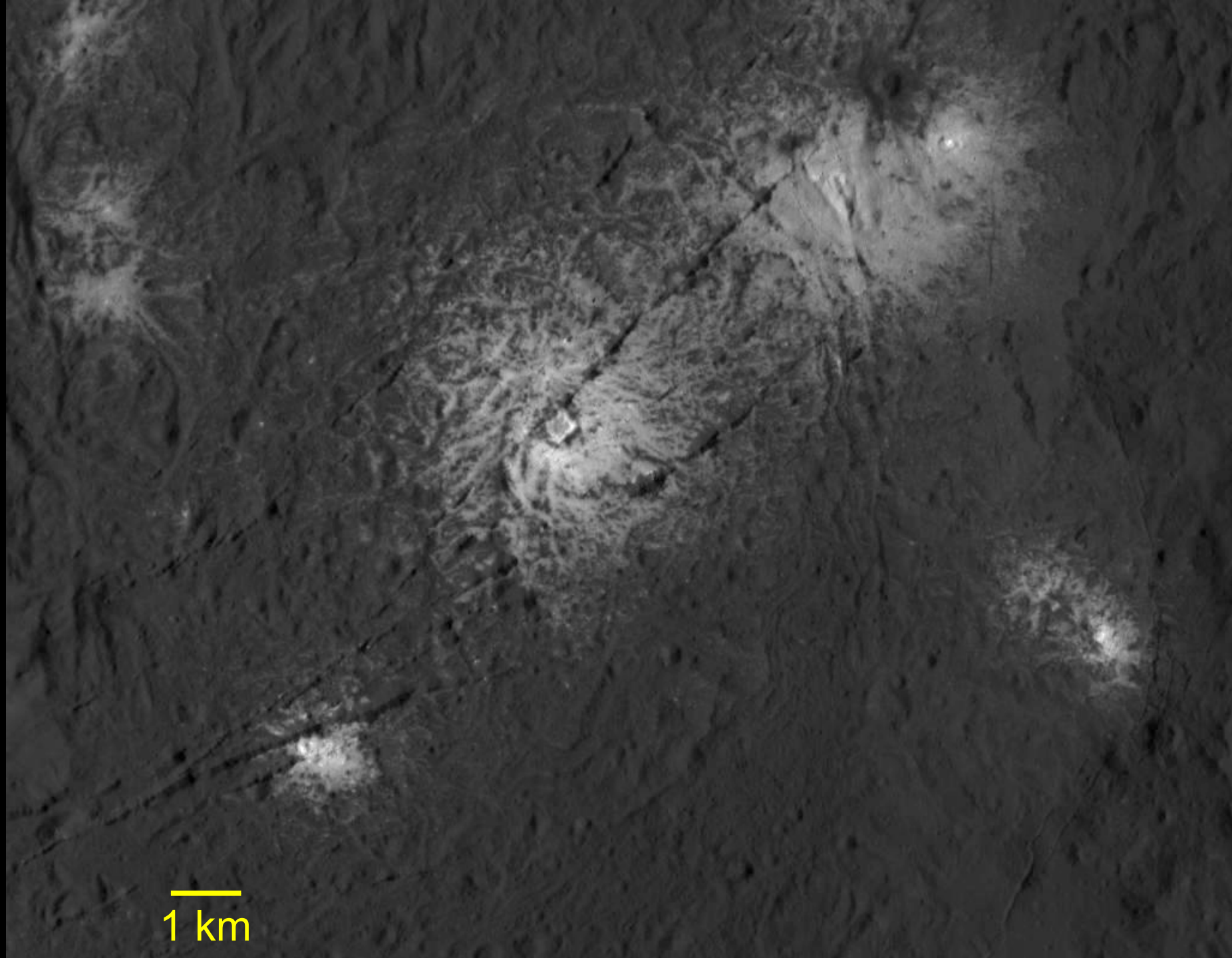
Periapsis shifts
south 1.9°/orbit

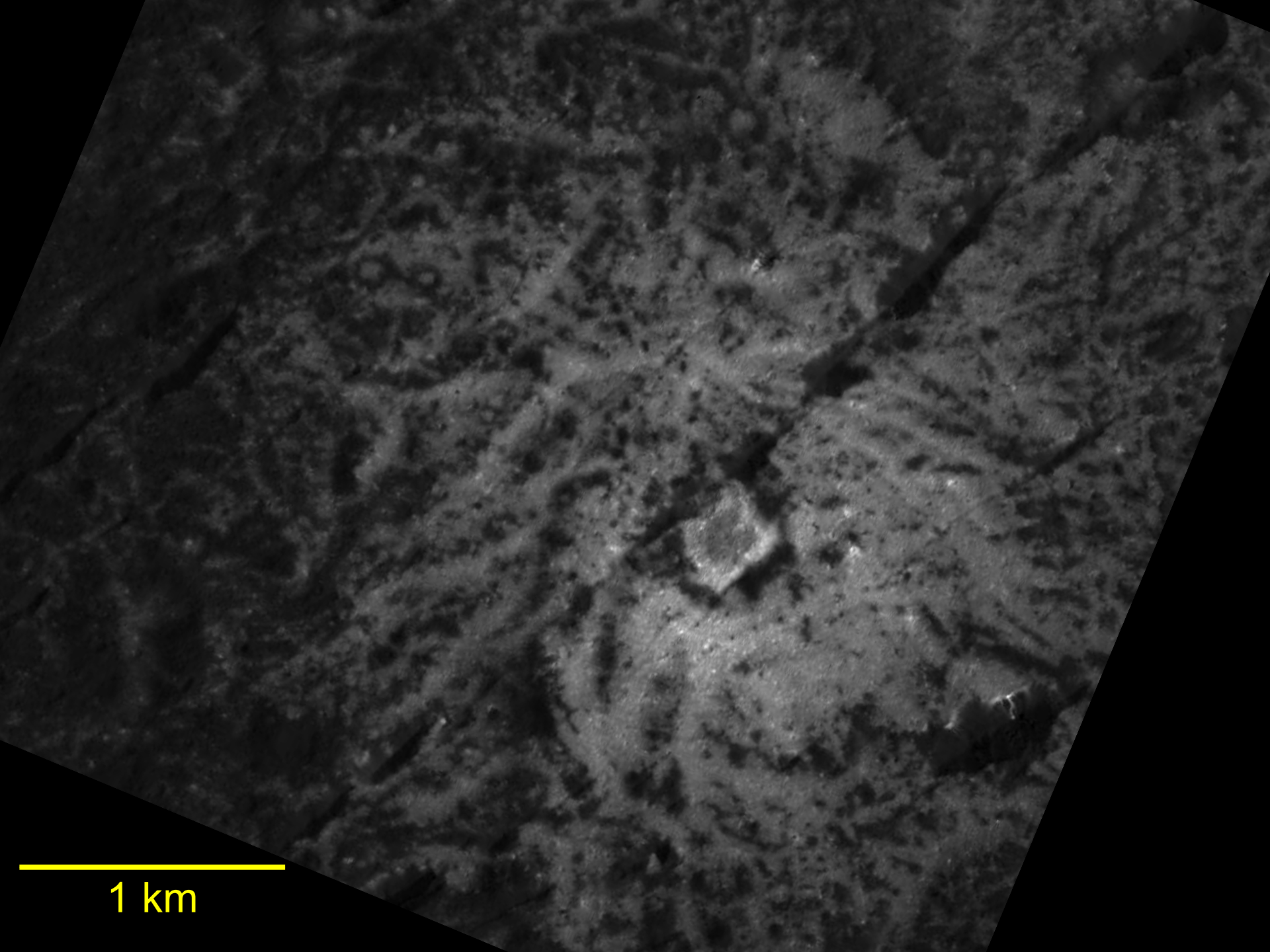


1 km

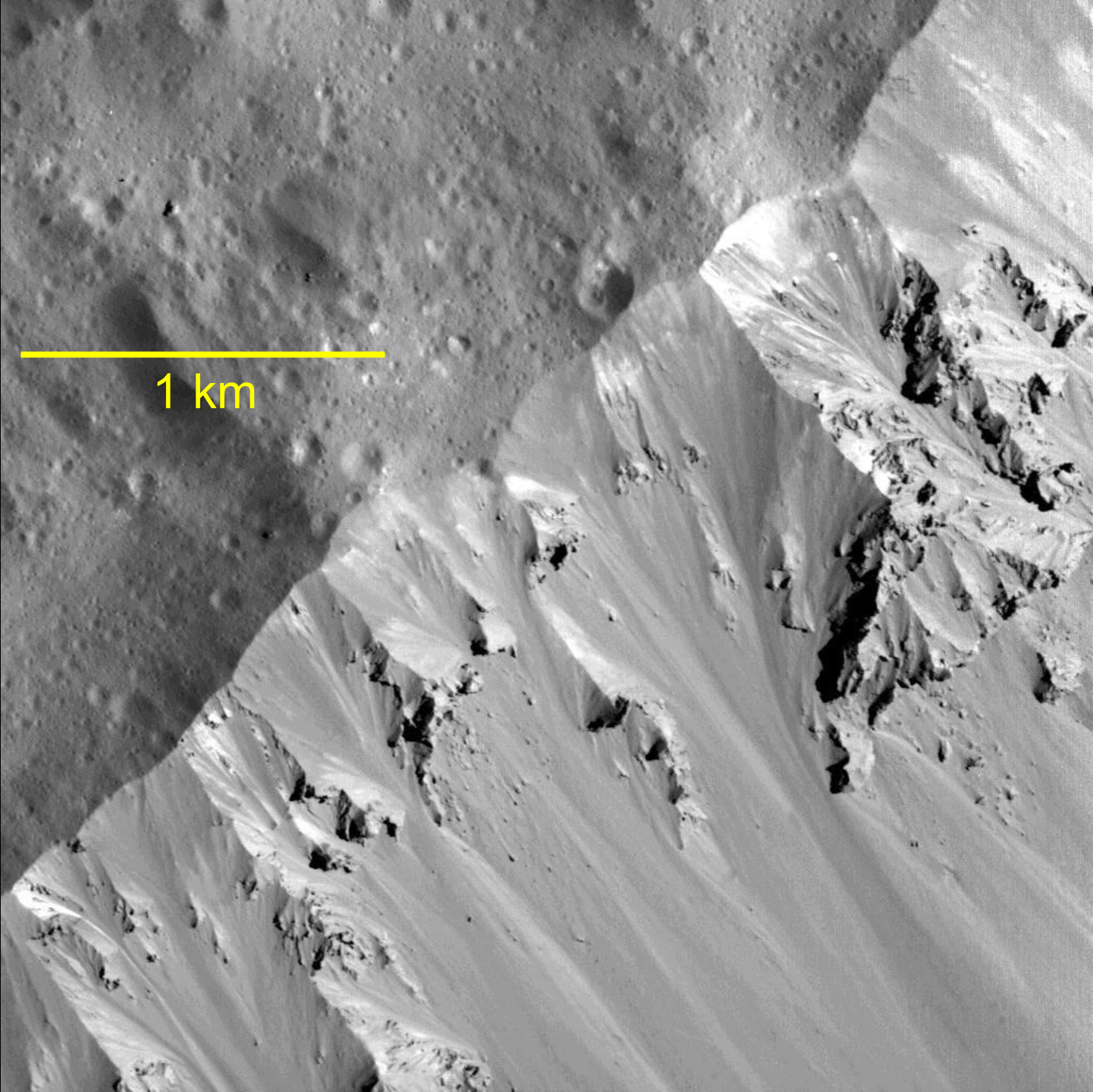


1 km

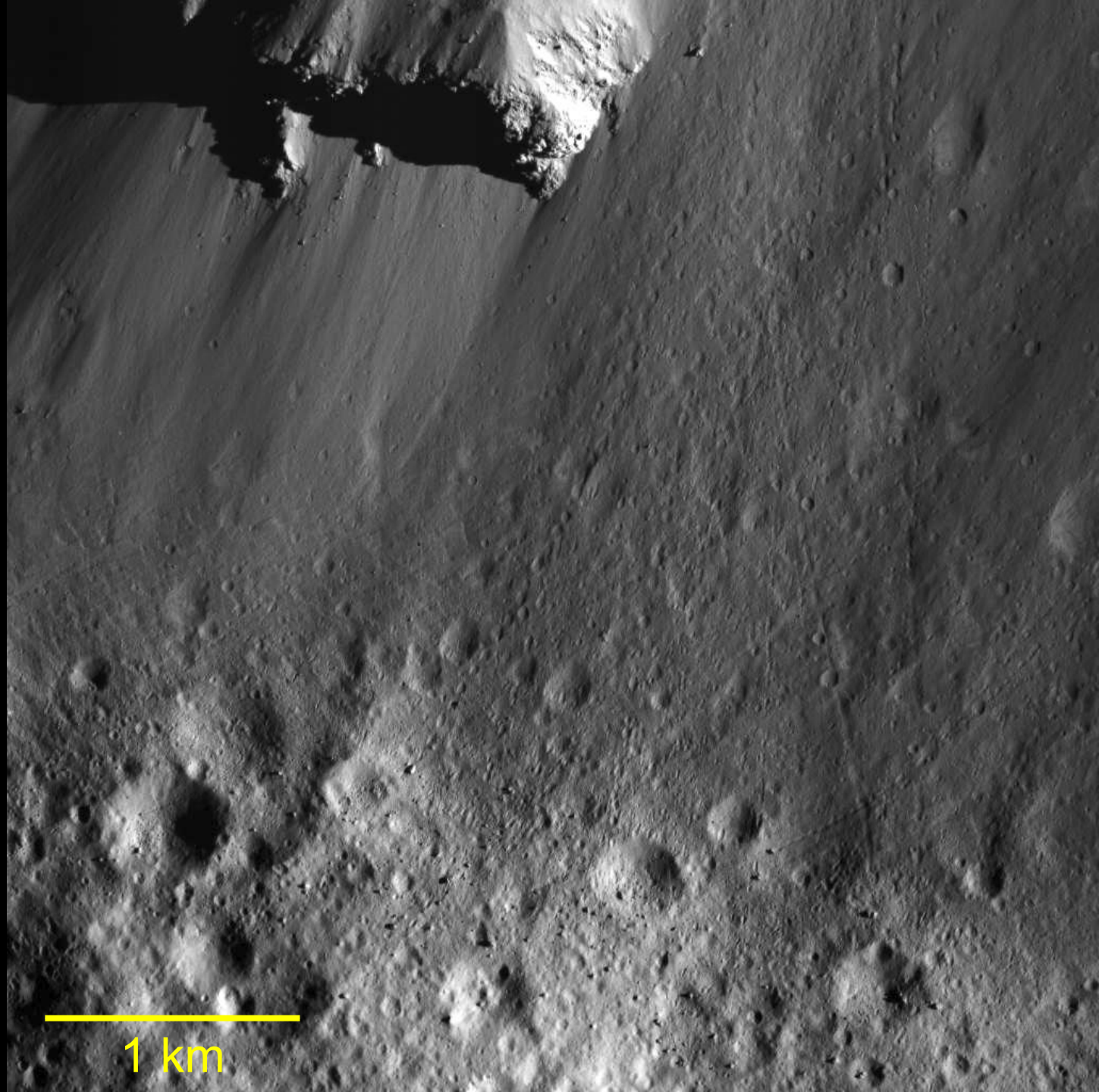




1 km



1 km



1 km

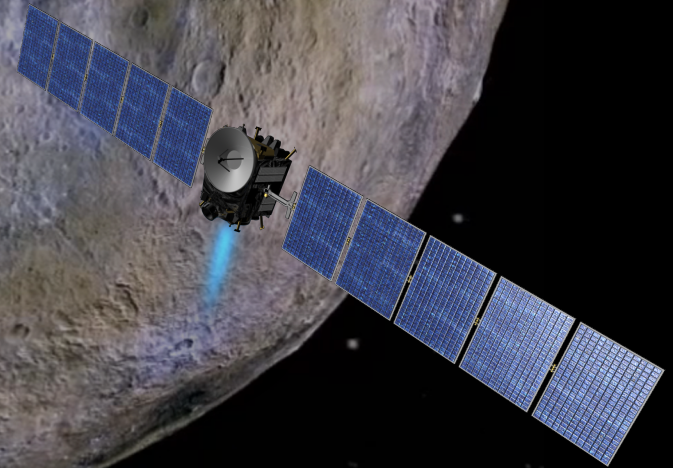
End of Mission

- With no reaction wheel control, Dawn uses hydrazine quickly in this orbit because of
 - High angular rates and accelerations to track the surface through periapsis
 - Gravity gradient torque
- The hydrazine is projected to be depleted between mid-September and mid-October
 - Yes, 2018
- Normal operations will continue as long as hydrazine is available.
- When the hydrazine is depleted, Dawn will lose attitude control and the mission will conclude.

Hydrazine:
The Final Frontier

Planetary Protection

- Because of its substantial inventory of water, organic materials and other compounds, and internal heat, Ceres is subject to planetary protection.
 - Dawn's orbital lifetime is required to be > 20 years.
- The current orbit was chosen to ensure compliance.
- Monte Carlo studies show lifetime > 20 years
 - Lifetime > 50 years with $> 99\%$ confidence



Conclusions

- Despite losing reaction wheel control, Dawn has exceeded all of its objectives at Vesta and at Ceres in its prime and two extended missions
- The spacecraft will continue to acquire unique high-resolution data until the mission concludes any moment now.....

